(12) UK Patent Application (19) GB (11) 2 317 256 (13) A

(43) Date of A Publication 18.03.1998

(21) Application No 9718275.2

(22) Date of Filing 28.08.1997

(30) Priority Data
(31) 19637053 (32) 12.09.1996 (33) DE

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(51) INT CL[6]
G08G 1/16, G01S 13/93 17/93

(52) UK CL (Edition P)
G4Q QCF

(56) Documents Cited
None

(58) Field of Search
UK CL (Edition O) G4Q QCE QCF
INT CL[6] G01S, G08G

(54) **Detecting right-hand or left-hand traffic**

(57) A method and device for automatically detecting whether right-hand or left-hand traffic prevails in a traffic situation or in a traffic environment, used in a vehicle within the framework of adaptive speed control, determines the prevailing orientation of the traffic flow on the basis of other vehicles approaching the said vehicle. For this purpose a frequency distribution is formed in accordance with a lateral distance y, a centre of gravity S of this frequency distribution is determined and the side of the controlled vehicle on which this centre of gravity S lies is established.

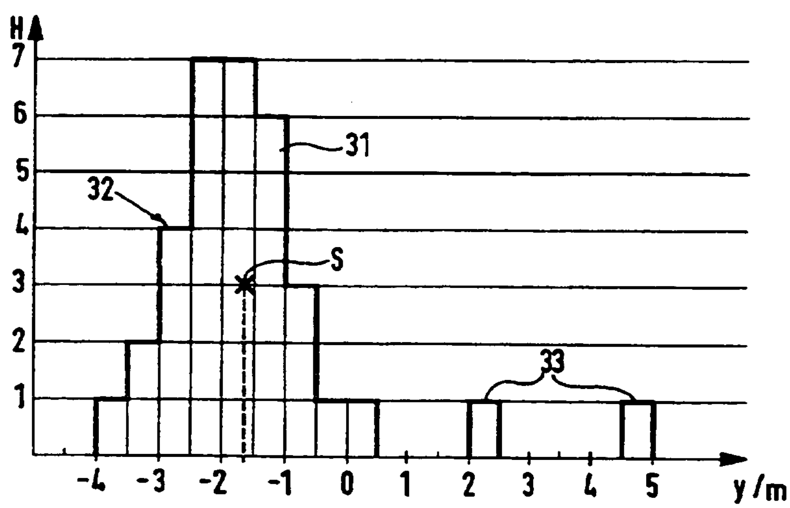

Fig. 3

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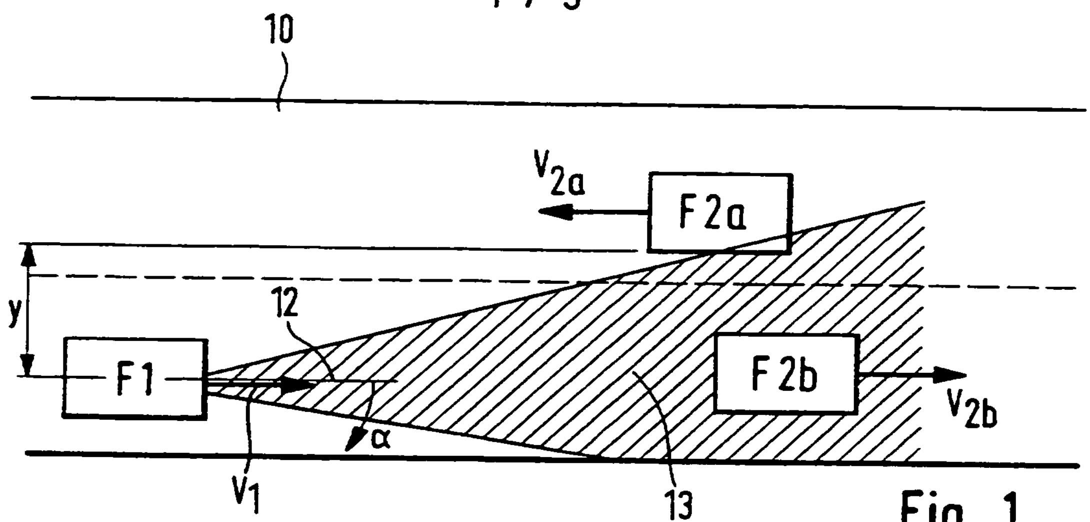


Fig. 1

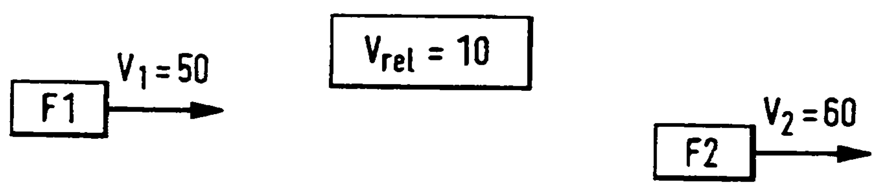


Fig. 2a

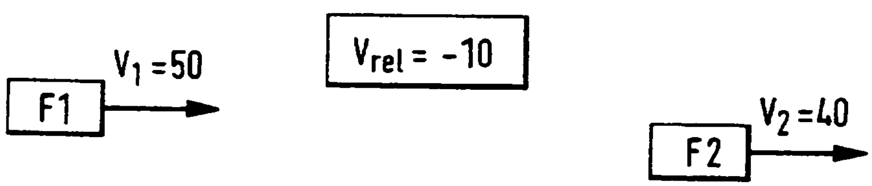


Fig. 2b

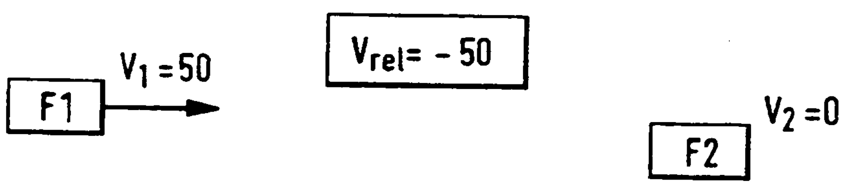


Fig. 2c

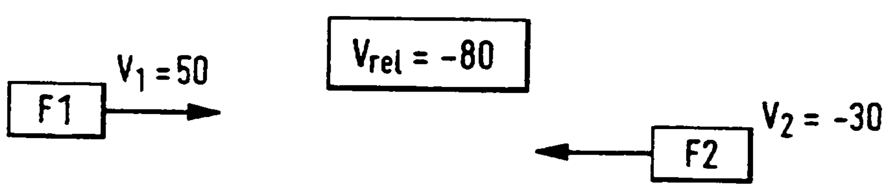


Fig. 2d

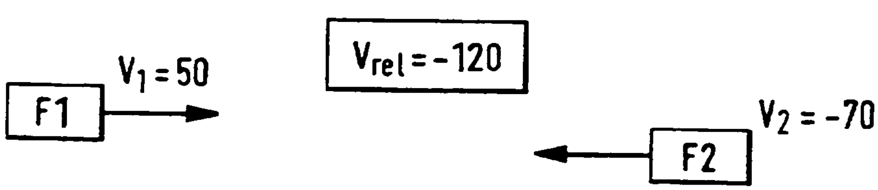


Fig. 2e

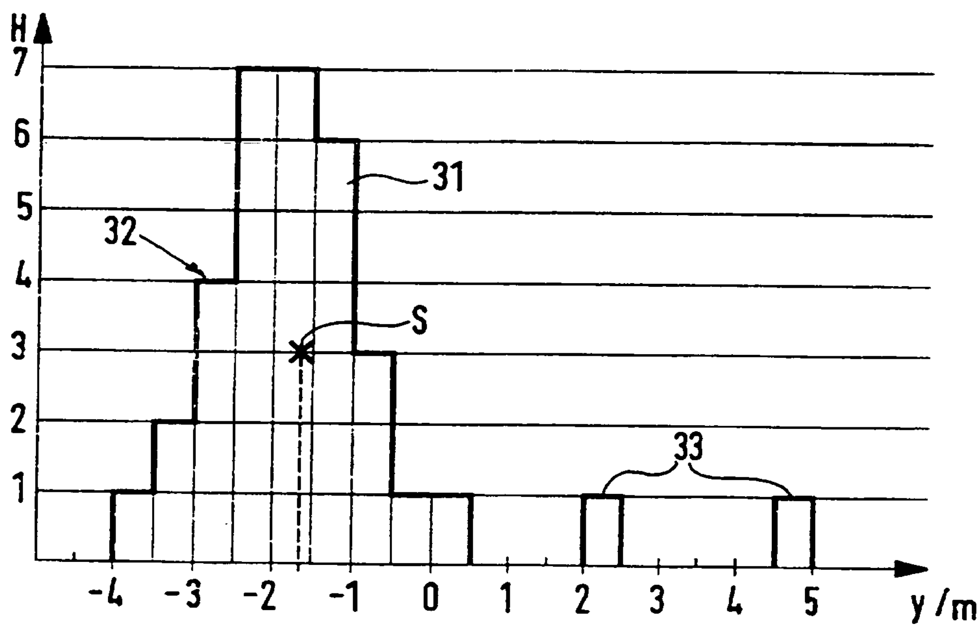
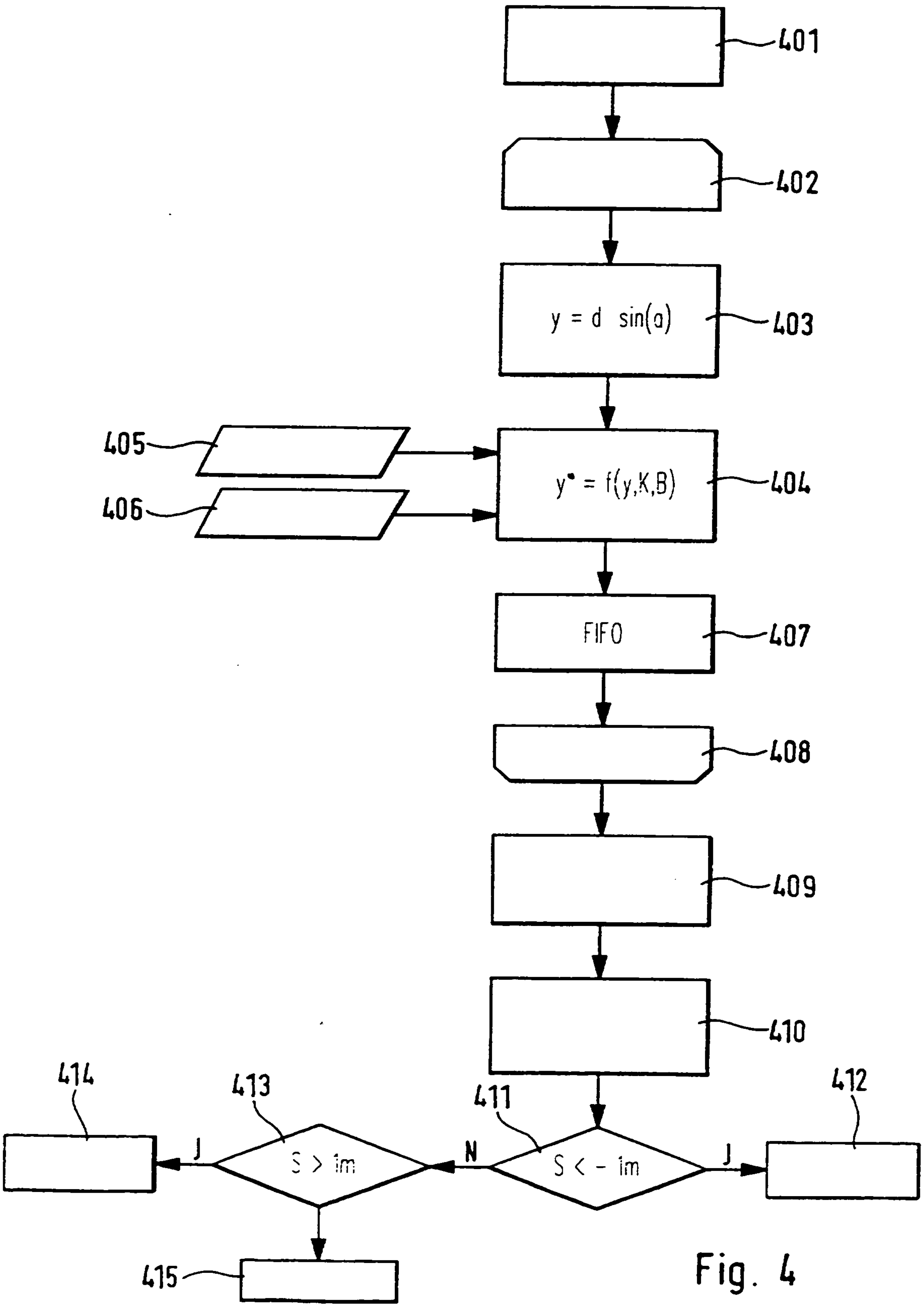


Fig. 3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y = d sin(a)
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y* = f(y,K,B)
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FIFO
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J
S > 1m
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S < - 1m
J
415

Fig. 4

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Method and device for detecting right-hand or left-hand traffic

Prior art

The invention relates to a method and to a device based on the latter for detecting the orientation of a traffic flow, i.e. for detecting whether right-hand traffic, as in many European countries and the USA, or left-hand traffic, as in Great Britain, for example, prevails in a traffic situation or in a traffic environment. The method is applied within the framework of adaptive or automatic vehicle speed control.

Adaptive vehicle speed control of this kind is described, for example, in DE 42 00 694 A1 (US 5,400,864), according to which the distance and speed of a vehicle in front are determined by means of a sensor, and the speed of the controlled vehicle is adjusted on the basis of this information. This illustrates the superimposition of distance control with respect to a vehicle in front on pure speed control. The essential content of this publication is that this distance control is interrupted for a period of time if certain conditions exist and automatically resumes its previous function at the end of this period. This enables the driver to accelerate the vehicle early, for example for an overtaking manoeuvre. This publication also refers to the fact that an overtaking operation of this kind may also be assisted by automatic acceleration by the control device. However for this to take place an overtaking operation must be automatically detected by the control device. This may take place on the basis of a direction of travel indicator, for example, in which case it is then necessary to additionally know whether an overtaking

operation is taking place on the right-hand or on the left-hand side. This in turn requires knowledge as to whether right-hand or left-hand traffic prevails in the traffic situation in question.

A method for the adaptive control of the speed of a vehicle is also described in EP 0 716 949 A1, which relates to the selection of a vehicle in front as a control target for distance control, if there is a choice between at least two vehicles. In this case it should be possible to overtake the vehicle which is not selected if it is travelling in a slower lane. However a vehicle in front which is travelling in a lane which is actually faster should not be overtaken. The decision in this respect is in turn dependent on the legal provisions applicable to the specific case and therefore ultimately on knowledge of the traffic flow direction at the time. This publication consequently already refers to the fact that the control device must be manually or automatically changed over between two different operating modes, according to whether right-hand or left-hand traffic prevails in the traffic situation at the time. However it does not describe any possibility of effecting an automatic change-over or of detecting the traffic flow direction, which is firstly required for such a change-over.

Object, achievement and advantages of the invention

The object of the invention is consequently to present a method and a device based on the latter which can automatically detect whether right-hand traffic or left-hand traffic prevails in a traffic situation or in a traffic environment.

This object is achieved according to the invention by an analysis of the signals delivered by a distance sensor with respect to oncoming traffic which is otherwise not usually taken into account. This is used as a basis to form a

histogram or frequency distribution which indicates how many oncoming vehicles have been detected at what lateral distance and in which lateral direction in each case. A centre of gravity of this frequency distribution is then formed. If this centre of gravity lies to the left of the controlled vehicle, right-hand traffic prevails. If the centre of gravity of the frequency distribution lies to the right of the controlled vehicle, left-hand traffic prevails.

A relative speed between the controlled vehicle and the object which has triggered a distance signal is advantageously determined in order to detect the oncoming traffic from all the signals delivered by the distance sensor. If this relative speed is lower than the negated actual speed of the controlled vehicle, the signal which is picked up must come from an oncoming vehicle.

The advantage of this method lies in the first place in the fact that, as opposed to the two above-mentioned publications, the orientation of the traffic flow can in fact be automatically detected. A further, particularly advantageous feature lies in the fact that no complex extension of the measuring and evaluation devices provided for adaptive speed control is required.

The automatic detection of the orientation of the traffic flow ensures that response modes of the control device with which the driver is familiar, such as, e.g. automatic acceleration for overtaking, function independently of the traffic flow direction prevailing at the time. This means that, on the one hand, a manufacturer does not have to adapt the control device in the factory or at the production stage to conditions specific to the country concerned.

On the other hand, the driver has the advantage of encountering controller responses with which he is familiar even during a brief visit to a country with an opposite

traffic flow direction. In contrast to a manual change-over system, this provides greater operational safety, as unexpected controller reactions due to operating errors, for example forgetting to perform a manual change-over, are excluded.

Description of an embodiment

An embodiment of the invention is illustrated in the following on the basis of drawings, in which

Figure 1 is a diagram of a traffic situation to which the method can be applied.

Figure 2 shows possible speed conditions of two vehicles for evaluating a relative speed.

Figure 3 shows a frequency distribution and

Figure 4 is a flow chart for carrying out the method according to the invention.

Figure 1 shows a two-lane carriageway 10, in the right-hand lane of which there is a vehicle F1. This is a controlled vehicle, i.e a vehicle with adaptive speed control according to the indicated publications. It is equipped with an angular-resolving distance and speed sensor for sensing and evaluating objects ahead of it in the direction of travel. This is preferably effected by means of a radar or laser sensor. The angular resolution may be achieved, for example, by space scanning with a sensing beam or by way of multi-beam sensors. Also shown in the figure are a reference axis 12 and the direction in which an azimuth angle α is measured.

The vehicle F1 is moving at a speed v_1. A vehicle F2b is drawn in front of it in the direction of travel, this

vehicle F2b moving in the same direction at a speed v_{2b}. A vehicle F2a moving at a speed v_{2a} in the opposite direction to the vehicle F1 is also in front of the vehicle F1 in the direction of travel, although in the opposite lane. Starting from the front of the vehicle F1, two lines diverging in the shape of a V span a region 13 which symbolises the sensing range of the speed and distance sensor. The vehicles F2a and b are in this case at least partly covered by the region 13. A quantity y denotes a lateral distance between the vehicles F1 and F2a. This may be related to the longitudinal axis of the vehicles, the sides of the vehicles or combinations thereof, according to the specific case.

A vehicle F1 and a vehicle F2, the respective direction of movement of which is indicated by a vector arrow, are drawn in each of Figures 2a to e. Different speeds v_1 and v_2 are also indicated by way of example. The two vehicles are moving in the same direction in Figure 2a, with v_2 being greater than v_1. The two vehicles are also moving in the same direction in Figure 2b, where v_2 is less than v_1. In Figure 2c the vehicle F1 is moving, whereas the vehicle F2 is stationary, which means that v_2 is equal to zero. In Figure 2d the vehicles F1 and F2 are moving in opposite directions, that is towards one another. v_2 consequently has an opposite, i.e. a negative sign and in this case is less than v_1. In Figure 2e the two vehicles F1 and F2 are also moving towards one another, v_2 now being greater than v_1 and the direction accordingly having a negative sign again. The relative speeds v_{rel} in each case resulting between the two vehicles F1 and F2 are also indicated in the five drawings, this relative speed v_{rel} being calculated from the difference of $v_2 - v_1$.

v_{rel} has a positive sign if the two vehicles F1 and F2 are moving away from one another, i.e. if the distance between them is increasing. In the reverse case a negative relative speed sign indicates that the distance between the two

vehicles F1 and F2 is decreasing. This corresponds to the physical definition of speed as the differentiation of a distance with time. A decreasing distance produces a negative differential.

As is obvious on the basis of these five illustrated examples, it can generally be said that the signed relative speed is lower than the negated actual speed of the vehicle F1 when the vehicles F1 and F2 are moving towards one another. This is utilised according to the invention to detect oncoming vehicles from signals delivered by the distance and speed sensor.

Figure 3 is an exemplary representation in graph form of a frequency distribution of identified, oncoming vehicles. Here a lateral distance y according to Figure 1 of, for example, -5 to +5 metres is plotted along the abscissa. The ordinate indicates a frequency, i.e. how often or how many oncoming vehicles have been detected at the respective associated distance y. Range or distance intervals are preferably formed for the purpose of a simplified association, these being taken as 0.5 metres as an example in this diagram. However greater or smaller interval divisions are of course also possible. The numerical values presented here are generally selected as an example for illustration purposes.

The graphical result is a stepped area 31 composed of individual bars. It is then possible to read from the bars 32, for example, that four oncoming vehicles have been detected at a lateral distance y of -2.5 to -3 metres.

The lateral distance y results from the data delivered by the distance and speed sensor, thus

$$y = d * \sin(\alpha)$$

where

y denotes the lateral distance to be determined,

d denotes the distance measured by the sensor,

α denotes the angle, determined by the sensor, at which the respective vehicle has been detected.

The angle α according to Figure 1 is preferably defined relative to the longitudinal axis of the controlled vehicle F1. A sign as an indicator of the direction for the distance y is thus produced from the sine term of the above equation. In the case of the counting direction of the angle according to Figure 1 which is selected here, a negative sign means that an oncoming vehicle F2a is located to the left of the controlled vehicle F1. The method according to the invention may of course also be implemented with a different angle definition and/or different reference values.

S designates a centre of gravity of the overall resulting bar graph. Similarly to a centre of mass of a homogeneous area, this can be determined by means of calculations which are generally known from physics. Its position is subsequently evaluated for the purpose of deciding whether right-hand or left-hand traffic prevails. According to the graph shown here as an example, the prevailing vehicles here are oncoming ones with negative values y. In this example this corresponds to the situation as illustrated in Figure 1, which means that oncoming vehicles are chiefly measured on the left-hand side of the controlled vehicle F1. However individual measured values may also appear in the other areas of the graph due to interference effects, ambiguities or measuring errors. This is illustrated as an example by the bar 33. However these interference effects are eliminated by an evaluation of the centre of gravity and an averaging process resulting from this evaluation.

Figure 4 shows a flow chart for carrying out the method according to the invention. All the oncoming traffic objects

are determined in step 401 on the basis of the relative speed and according to Figure 2. This means that the signals which obviously come from an oncoming vehicle are selected from all those delivered by the sensor. A loop is created in steps 402 and 408 which is passed through each time oncoming vehicles have been detected. The lateral distance y is then determined in step 403 for each oncoming vehicle. It is calculated on the basis of the measured distance d and the measured angle α. A corrected lateral distance y^* is determined in step 404, which is preferably included. This is no longer related to the vehicle F1, but rather to its lane. It results as a function of the previously determined distance y and on the basis of data relating to the curvature K of the carriageway and its width B. These data are in turn determined in steps 405 and 406, using video processing, for example, and fed to the calculating stage 404. The steps 404 to 406 correspond to an advantageous development of the invention, although are not absolutely necessary.

The previously determined distances y or, according to the advantageous development, the distances y^* are stored in a memory in step 407. This may be a FIFO memory (First In First Out), for example. The basic concept here is that a number of measured values, for example 1000, are stored and each time a new measured value is stored the one which is the oldest leaves the memory. This enables the measurements - in this case 1000 - which are the most up-to-date to be accessed.

A frequency distribution or histogram according to Figure 3 is now formed from all the stored data according to step 409. The centre of gravity S of the resulting frequency distribution is determined in step 410. The side on which this centre of gravity S lies, i.e. at which y values it lies, is now checked to establish the orientation of the traffic flow. For this purpose an inquiry is firstly made

according to step 411, for example, as to whether S lies at y values of less than -1 metre. If the answer is in the affirmative, the traffic is right-hand traffic, in accordance with step 412. This corresponds to the representation of Figure 3. If the answer is in the negative, a check is carried out in step 413 as to whether the centre of gravity lies at y values greater than 1 metre. If this is the case, the traffic is left-hand traffic, in accordance with step 414. If this question also receives a negative reply, obviously no definite statement is possible, as indicated by step 415.

The sequences of inquiries 411 and 413 as well as the reference quantity of one metre are given here as an example again. The reference value which is interrogated or checked may also be smaller or greater, according to empirical values. The sequence of inquiries may also be interchanged.

In order to save storage capacity and computing time, the updating of the stored measured values by means of new values and the calculation of the histogram may be combined as an alternative to the separate steps 407 and 409. For this purpose the histogram is calculated once after the system has been put into operation for the first time or each time this is repeated on the basis of the first stored measured values. Each further measured value now obtained for the first time is incorporated directly into this existing histogram. At the same time the stored frequencies at the individual distance intervals are decreased by a selected percentage or fractional value, so that the total sum of all frequencies always remains constant.

A definite statement may fail to be obtained, as in step 415, if, for example, there are too few measured values which can be evaluated. In this case, according to a first development of the invention, a neutral controller reaction, without right-hand/left-hand discrimination, is assumed.

This neutral reaction corresponds to a vehicle speed control which has no right-hand/left-hand discrimination from the outset.

According to an alternative, second development of the invention, the last known state of the system is maintained. Storage in or on a non-volatile storage medium, for example, may in turn be implemented and used for this purpose.

A further development of the invention which is more reliable in informative terms is achieved if at least two histograms are employed. A first histogram H_{fast} comprises, for example, all detected vehicles with very high relative speeds, these usually being oncoming vehicles. A second histogram H_{slow} comprises all detected vehicles with comparatively low relative speeds, i.e. predominantly vehicles travelling in the direction of the controlled vehicle. If two events A and B are now defined according to

A: centre of gravity S in H_{fast} at negative values, i.e. probably right-hand traffic and

B: centre of gravity S in H_{slow} at positive values, i.e. probably right-hand traffic,

a reliable decision can be made by logically linking the two events. For example, there is a greater probability of right-hand traffic if both events are true, if, therefore, $A \cap B$ applies, where "$\cap$" denotes the Boolean operator "and". In the reverse case there is a greater probability of left-hand traffic if (not_A) $\cap$ (not_B) applies, where (not_A) and (not_B) denote the Boolean negations of the events A and B. The absence of a definite statement results when only one of the two defined events occurs, thus, for example, A $\cap$ (not_B).

According to a further development, the event A may be given priority here. The event B, i.e. an evaluation of the histogram H_{slow}, is then only used for the case in which a reliable decision solely on the basis of the histogram H_{fast} is not possible.

Claims

1. Method for automatically detecting whether right-hand or left-hand traffic prevails in a traffic situation or in a traffic environment, characterised in that the said method is used in a vehicle, and that the prevailing orientation of the traffic flow is determined on the basis of other vehicles approaching the said vehicle.

2. Method according to claim 1, characterised in that the oncoming vehicles are detected on the basis of their relative speed.

3. Method according to claim 1 or 2, characterised in that lateral distances (y) of the oncoming vehicles from the said vehicle are determined.

4. Method according to claim 3, characterised in that the lateral distances (y) of the oncoming vehicles are determined on the basis of an angular position (α) and a distance (d) from the said vehicle.

5. Method according to claim 3, characterised in that corrected lateral distances are determined from the lateral distances (y) and from data on the curvature and/or the width of the carriageway.

6. Method according to one of the preceding claims, characterised in that at least one frequency distribution is formed for the determined lateral distance (y) or the determined corrected lateral distances.

7. Method according to claim 6, characterised in that distance intervals are formed in order to form the said frequency distribution, of which there is at least one.

8. Method according to claim 6 or 7, characterised in that a centre of gravity S of the said frequency distribution, of which there is at least one, is determined.

9. Method according to claim 8, characterised in that the prevailing orientation of the traffic flow is determined from the position of the centre of gravity S of the frequency distribution, of which there is at least one.

10. Device for automatically detecting whether right-hand or left-hand traffic prevails in a traffic situation or in a traffic environment, the said device being fitted in or on a motor vehicle and comprising means

- which sense at least objects located in an area in the vicinity of the front of the vehicle,
- which detect oncoming vehicles from the sensed objects and
- which determine the prevailing orientation of the traffic flow on the basis of the detected oncoming vehicles.

11. Device according to claim 10 comprising means

- which determine a relative speed of the sensed objects and
- which detect oncoming vehicles on the basis of the determined relative speed.

12. Device according to claim 10 or 11 comprising means

- which determine the lateral distances of oncoming vehicles from the said vehicle and
- which form at least one frequency distribution on the basis of the said distances.

13. A method substantially as hereinbefore described with reference to the accompanying drawings.

14. A device substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

15

Application No:	GB 9718275.2	**Examiner:**	Mike Davis
Claims searched:	1-14	**Date of search:**	6 October 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G4Q (QCF, QCE)

Int Cl (Ed.6): G08G, G01S

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	None	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

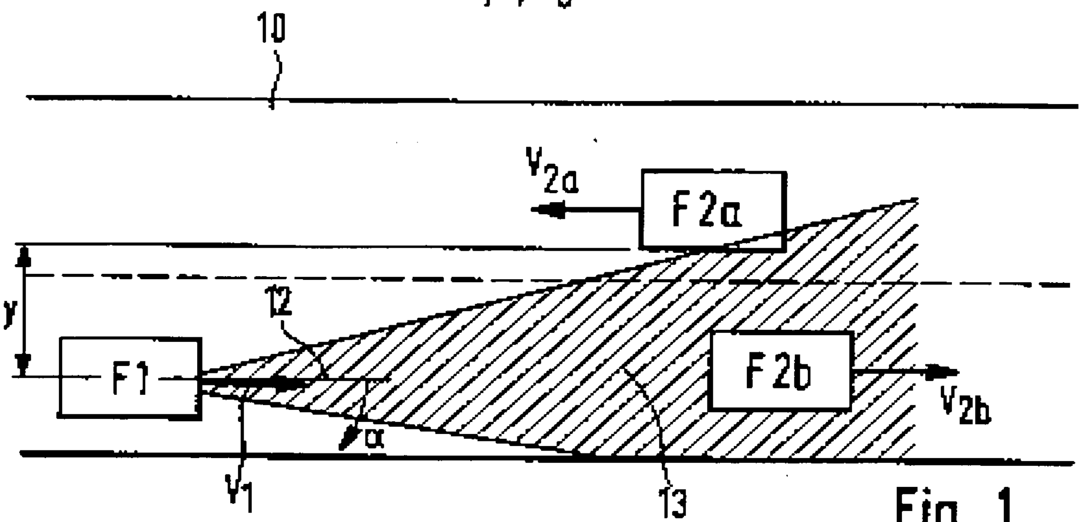


Fig. 1

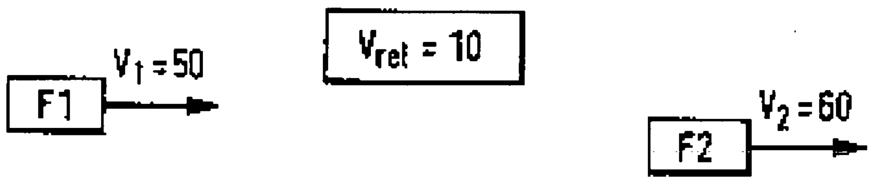


Fig. 2a

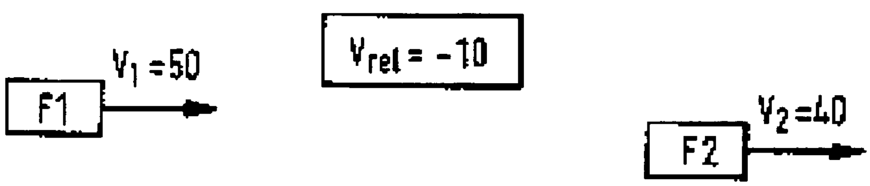


Fig. 2b

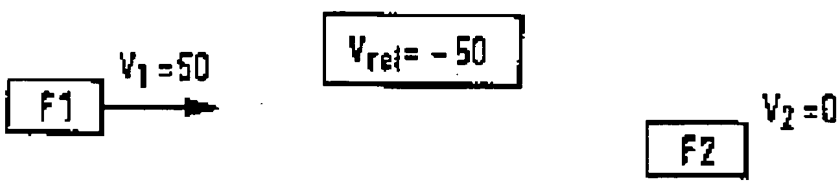


Fig. 2c

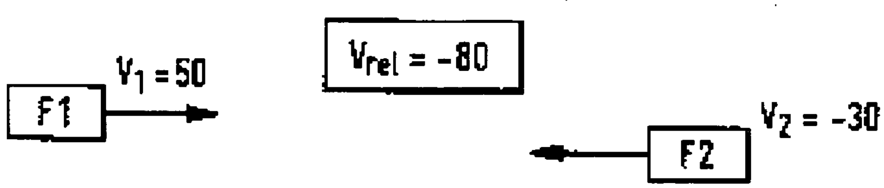


Fig. 2d

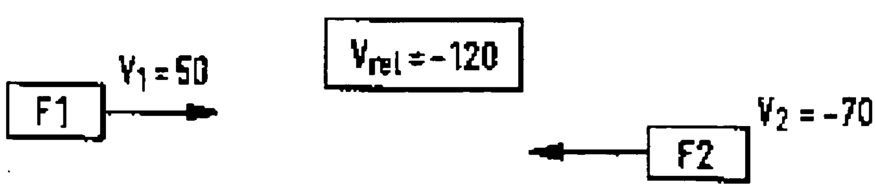


Fig. 2e

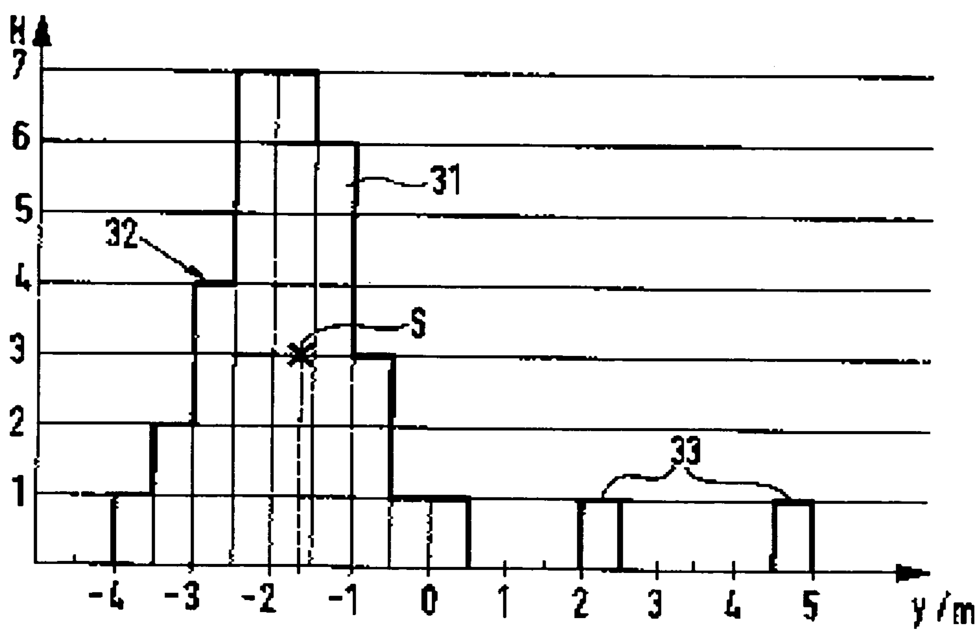
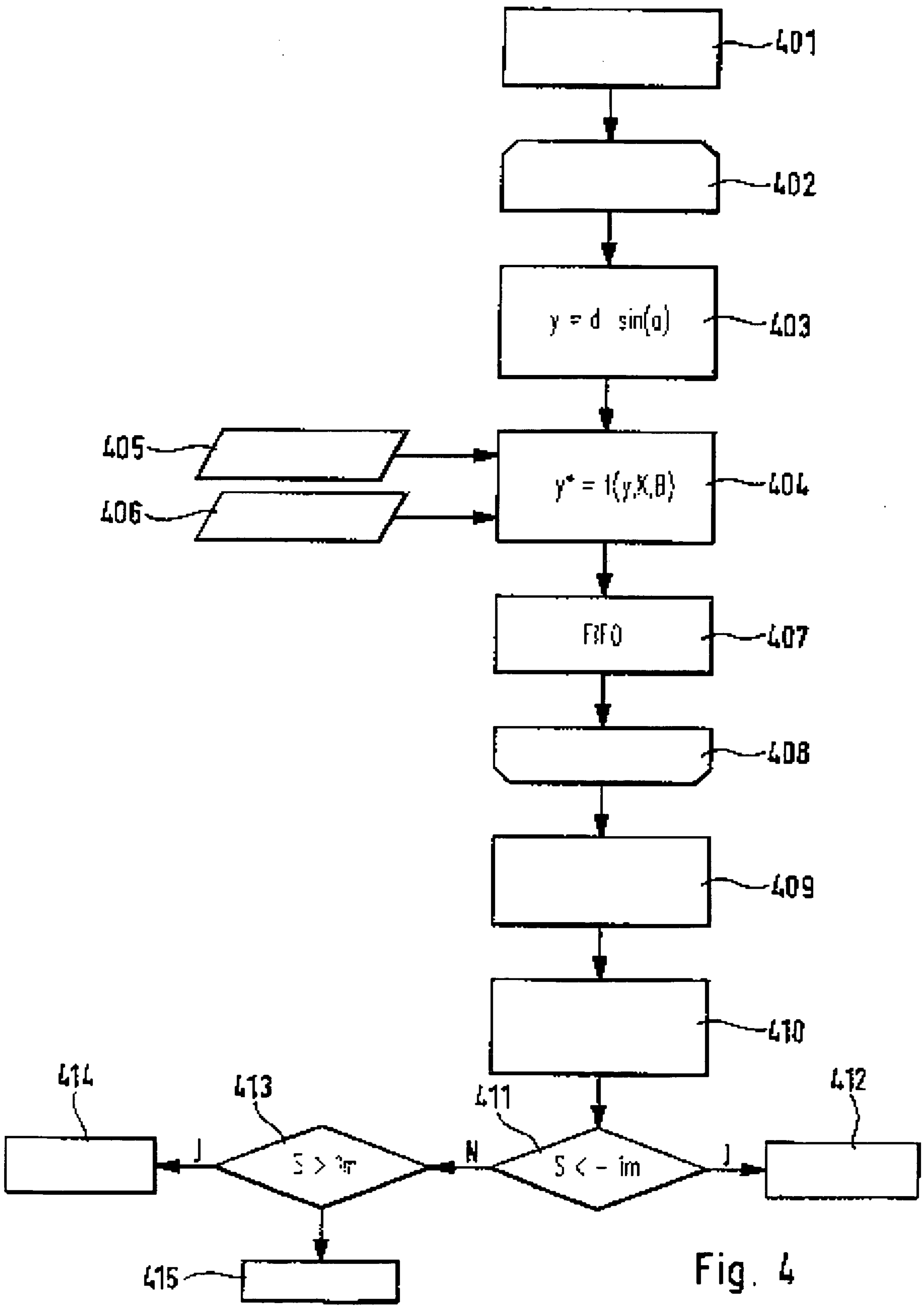


Fig. 3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y = d sin(α)
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Fig. 4